

**Written Testimony for Hearings by The United States Senate**

**Committee on Agriculture, Nutrition, and Forestry**

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**Biomass Use in Future Energy Production:  
Demonstration and Commercial Application for Agricultural  
Bioproducts and Cellulosic Biomass Use**

**Testimony of:**

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**Summary Points:**

- Cellulosic biomass produced on American farms can contribute significantly to the nation's energy self sufficiency and to both its economic and ecological health.
- The American farmer and the American consumer should both benefit economically from increased reliance on biomass derived fuels
- The costs of biomass - derived fuels to society both now and in the future are likely to be much lower than costs of fossil-derived fuels.
- A focus on the biomass utilization that minimizes net usage of imported energy, maximizes net reduction in greenhouse gas emissions, and gives credit for reduction in societal costs of energy production would accelerate near term incorporation of cellulosic biomass into a US energy strategy.

Thank you Mr. Chairman and the members of this committee for the opportunity to speak before you today. The research and production issues related to the use of cellulosic biomass for bioenergy production have been a major focus of my work at Oak Ridge National Laboratory(ORNL) for the past 12 years as a member of the Bioenergy Feedstock Development Program. The Department of Energy (DOE) supported this work at ORNL for more than 24 years. Its purpose was to identify and develop bioenergy crops and to evaluate their potential to contribute to biomass energy and bioproducts for national needs. I can tell you that there is tremendous enthusiasm among both researchers and farmers for the opportunity to utilize economically viable bioenergy crops and to contribute in a significant way to this nation's energy needs and its energy security.

Today I will share with you some of what we have learned about production and economic potential of a model bioenergy crop, switchgrass, a highly productive and resource-efficient perennial grass native to the Eastern two-thirds of the country. Switchgrass is a cellulosic feedstock that was selected to be grown as a dedicated bioenergy crop in the immediate vicinity of industry that would use it for bioenergy or bioproducts. This distinguishes it from other types of cellulosic feedstocks such as forestry and mill residues, urban wood wastes, and agricultural residues for which feedstock availability is linked to the distribution and intensity of the industries that produce these waste streams.

As this nation implements strategies to improve its energy self sufficiency we will need to use many types of feedstocks and deploy many types of technologies to displace significant amounts of fossil fuels and to reduce emissions of greenhouse gases that they produce. In this process it would seem that several criteria would help guide the direction in which we proceed and measure the efficacy of our efforts. Below are some criteria which may prove useful. I will use them in following sections to measure progress that our research suggests can be made using switchgrass as a test case.

### **Some Criteria/questions for Evaluating the Bioenergy Production Potential of Energy Crops:**

1. What is the net fossil energy displacement potential per unit of land area used to produce the crop?

2. What is the net reduction in greenhouse gas emissions associated with energy produced through using the crop as a feedstock?
3. Are the economic benefits of producing the crops sufficient to attract growers at prices that industry is willing to pay?
4. Is production agriculture for the crop compatible with existing agricultural practices across a broad region?
5. Are there ecological benefits that make the crop valuable to land management systems at a local and regional level?
6. Are there secondary products that can be derived from the feedstock to improve its production/conversion economics?
7. What are the net societal values of incorporating the energy crop production into the national energy and agricultural production strategy?

While questions 1, 2 and 7 are the most critical measures of meeting the need to reduce the level of our dependency on fossil fuels, questions 3-6 address characteristics that determine whether a crop is even viable as a candidate for bioenergy production. The landowner/producer is a key player in cellulosic crop production and ecological and economic compatibility with existing farming practices is a prerequisite for widespread acceptance of a crop by the farming community.

Switchgrass was chosen as a model crop based on preliminary research that showed it to produce very high yields (5-10 tons/acre) with low requirements for both water and fertilization. Because it is a perennial forage species that can be produced and harvested like a hay crop, the management intensity and energy requirements for producing switchgrass are low and the equipment to plant and harvest it is already widely available. There are currently 60 million acres of hay, 14% of total US cropland, produced in the US and much of the same equipment can be used to harvest switchgrass. Switchgrass is in fact an excellent forage species for cattle and its relatively high leaf protein content is leading to its being considered as a source of animal feed protein.

From a land management perspective, switchgrass has an extremely deep and active root system which anchors the soil against erosion losses while adding approximately one ton of carbon per year to the soil profile. Soil carbon is extremely important to soil stability, soil quality, and retention and supply of nutrients through root turnover. In many cases we find that the total root mass maintained by switchgrass is equivalent to the annual aboveground biomass harvested for forage or energy. Growing switchgrass

will be most favorable to eroded croplands where decades of annual crop production have often reduced soil organic matter by as much as 25%. Under these conditions growing deep-rooted perennial species like switchgrass can help restore soil fertility and the capacity for soils to hold and supply water and nutrients. For this reason switchgrass is among the preferred species planted in the Conservation Reserve Program to protect and restore the productivity of our nations agricultural lands. Approximately 30 million acres, 7% of this nation's crop land is in this program.

When ORNL/BFDP began intensive research on switchgrass in 1992, we were able to build on decades of research on this species based on its value as a forage grass (see review by Moser et al, 1995). Evaluation of biofuels potential however entails somewhat different criteria than management for forage production. From, 1992 until 2002, significant progress was made in characterizing the breeding biology of switchgrass, developing new cultivars for energy production, and defining management strategy and costs, ecological benefits, and the potential for biotechnology applications.

Research on switchgrass production biology, ecology, and management potential to date has reinforced early projections that this species could play an important role as an energy crop. However, since deployment of energy crops in this country has been very slow, we have had to rely on models to project what we know to the larger scale where production economics and competitiveness with other crops are critical features. An enormously useful tool in this regard has been POLYSYS, a regional econometric model developed jointly by a team of scientists at ORNL/BFDP, the US Department of Agriculture, and the University of Tennessee (Ugarte et al., 2003). POLYSYS is an agricultural policy simulation model of the US agricultural sector that considers national demand for crops, their regional supply and established prices, and their potential impact on farm income. Thus POLYSYS can be used to characterize regional production amounts and the impact of crop introduction or alterations on the agricultural economy.

Since large scale markets for bioenergy crops like switchgrass do not presently exist, POLYSYS, allows one to use what we know about production costs of any energy crop to ask how profitable and hence how competitive it would be at various entry prices into agricultural markets – Would it be grown and where and what would the impacts on agricultural markets and farm income be at various entry prices?

Initial simulations with POLYSYS were directed towards comparisons among three leading energy crop candidates: switchgrass and two short rotation woody crops, hybrid poplar and willow. Results indicated that at present production costs, switchgrass would be the most economically competitive of these energy crops on 99% of available crop lands when maximum production potential was sought. A summary of the acreage of cropland and CRP land projected to convert to switchgrass, average yields on those lands, and impacts on the agricultural economy at three prices are shown in Table 1.

**Table 1. Projected production characteristics for land planted to switchgrass as a function of prices offered to farmers at the farm gate.<sup>1</sup>**

	<u>Production Characteristics</u>		
<b>Farmgate price (\$ per ton)</b>	<b>27.58</b>	<b>40.04</b>	<b>47.65</b>
<b>Area planted (millions of acres)</b>	<b>7.62</b>	<b>21.3</b>	<b>52.4</b>
<b>Average yield (tons per acre)</b>	<b>4.88</b>	<b>4.14</b>	<b>3.96</b>

<sup>1</sup>From McLaughlin et al., 2002.

In addition, , because POLYSYS is linked to agricultural policy options, including government price supports for crop prices or land allocation to CRP, simulations can provide perspectives on changes in both government support of agriculture as well as prices of other crops and, most importantly, changes in net income to farmers. A summary of these parameters for the same three switchgrass prices included in Table 1 is provided in Table 2 below.

**Table 2. Projected changes in farm income and government costs at three farmgate prices for switchgrass produced as an energy crop.<sup>1</sup>**

	<u>Farmgate price (\$ per ton)</u>		
	27.8	40.04	47.65
	<u>Economic Benefits (\$ millions)</u>		
<b>Increased Farm Revenue</b>			
From switchgrass	150	2272	4437
From other crops	1161	3653	3312
Total Revenues	1311	5925	7745
<b>Reduced Government Subsidies</b>	1253	4035	5770
	<u>Total Economic Benefits (\$ Billions)</u>		
	2.5	9.9	13.5

<sup>1</sup>See McLaughlin et al. 2002 for a more complete cost accounting.

Table 2 represents a simplification of total societal costs and benefits, which are projected to include both increased prices for crops displaced by switchgrass and reductions in the very substantial societal costs that stem from use of fossil fuels. However the data shown here indicate that substantial acreages of switchgrass would be expected to be produced at these prices and that the level of production can be greatly influenced by rather small increases in farm gate prices. For example, the price shift from \$40 to \$47 per ton as shown above would increase projected acreage planted to switchgrass by over 30 million acres.

To produce large acreages of switchgrass at a given price is meaningless however if the associated price of switchgrass isn't competitive with the fossil fuels it is intended to supplant. McLaughlin et al. (2002) have compared the price of switchgrass as both a fuel to the energy industry and as an energy provider to society. The former considers only the energy contained in the feedstock, while the latter includes secondary market

values, such as reductions in greenhouse gases (valued at \$25 per ton of carbon emissions reduction), increased farm income, and reduced levels of government subsidies needed to support farm income. Even without including major components of societal value such as reduced health effects and economic impacts of oil price shocks, McLaughlin et al (2002) found that societal costs of energy derived from switchgrass would be well below current prices paid for both oil and natural gas.

In fact society does not now do a full cost accounting of its energy supplies and new energy sources must compete with fossil fuels on a very uneven playing field, which includes substantial subsidies to the fossil fuel industry. One must ask “how effective could government policy be in helping promote more equitable valuation of US energy options?” As a case in point McLaughlin et al. (2002) calculated that a very modest price support of \$10 per ton value at the \$27/ton production level would cost \$1.58 billion annually and provide an annual increase in farm income of about \$4.7 billion: a benefit:cost ration of about 3:1. Projected reductions in government subsidies not required as a result increased farm income could totally pay for this infusion of funds into the farm economy.

At present corn ethanol is the major source of transportation fuels derived from renewable energy in the US. Despite the relatively high energy costs of producing corn ethanol, it has been responsible for an extremely important beginning in the production of renewable energy from biomass and should continue to play an important role. In the mean time highly efficient cellulosic feedstock such as switchgrass coupled with corn offer a way of substantially improving the net energy returns and the rate of reduction of greenhouse gas emissions per unit of land and per unit of cost in resources. In addition the inclusion of perennial crops like switchgrass in the feedstock supply structure will allow a much more regionally distributed cross section of farmers to participate in this nation’s search for improved energy self sufficiency. This includes notably depressed farm economies in the eastern US, where corn is much less important than in the Mid-west.

It is hoped that the vital role of the American farmer will be promoted and recognized as a vital part of the energy supply industry and that the farm community can share fully in the economic benefits that will be associated with its efforts. What is vitally needed is a strategy to bring these and other renewable feedstocks into to the nation’s energy supply structure so that the

benefits to society at local, regional, and global scales can be realized. I thank the committee again for allowing me to share these thoughts with you.

### **Literature Cited**

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